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THE GENERAL REQUIREMENTS FOR PHOTOGRAPHIC LIGHTING

By
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SUMMARY

The paper discusses problems encountered in studio lighting and deals with the following points:—

1. *The colour temperature of the lamps employed, and a rational method of lamp rating.*
2. *The critical nature of voltage variations.*
3. *Vapour discharge lamps.*
4. *The use of spill rings and methods of avoiding their use while securing greater lighting efficiency.*
5. *Modern designs of lamps which avoid "hot rings" between "flood" and "spot" positions.*
6. *The correct use of diffusers.*
7. *The use of filtered arc lamps combined with incandescents for colour work.*

WITHIN the scope of a paper to be delivered in a fairly short time it is possible to give only a general outline of requirements which lead toward ideal equipment for motion picture lighting, and I have, therefore, endeavoured to set forth a few essentials for such equipment to show how past experience has enabled us to construct lighting units of new design which more nearly embody these ideal essentials.

Importance of Colour Temperature

Although the ideal light source has not yet been evolved, generally speaking it is desirable to have a light source with a fairly large range of sizes, that is one which will emit different intensities with a more or less fixed spectral composition—which we usually describe as colour quality, or, more correctly, colour temperature of the source—the colour temperature, of course, depending on the film emulsion.

Since the advent of sound in motion pictures the prime essential has been quiet operation of the source. The incandescent lamp best meets the need of steadiness and quietness, and if adequate voltage control is possible, the colour temperature of this source can be held for very satisfactory use in exposing panchromatic film stock.

One of the very common practices which should be corrected is the general use of lamps which, when burned at their rated voltage, operate at considerably different colour temperatures. This is a practice which came into being by reason of the lamp manufacturers' method of rating the lamp as to its average life rather than to its light output.

Rating Lamps by Filament Temperature

For photographic lighting it is much more desirable to rate lamps with regard to their lumen per watt or colour temperature characteristic. This step has already been taken in the production of Photo flood lamps which are designed to operate at a colour temperature of 3,440 degrees Kelvin. As tungsten melts at 3,665 degrees Kelvin the life of a 250 watt lamp is approximately two hours, but by reason of the greater bulk of the filament, the life of a 5 k.w. lamp is approximately 40 hours.

It would be desirable to have a complete line of incandescent lamps to operate at about 3,275 degrees Kelvin, which is the rating of the present 5 k.w. lamp in general use, so that all lamps on the set would be operating at the same colour temperature.

In ordinary practice lamps vary from around 3,000 degrees Kelvin up to 3,275 degrees and, although this is not critical in black and white photography, it is not

at all permissible in colour photography with the processes now available for commercial use.

Since the colour temperature of an incandescent lamp varies rapidly with a change in voltage, it is important to have adequate voltage control when incandescent lamps are generally used. Incandescent lamps have the advantage of being divisible into small or large units. We can have Baby Spots using 250 watt or 500 watt lamps, and from thereon up with a range of 1,000 watt, 2,000 watt, 3,000 watt, 5,000 watt and 10,000 watt units. No other light source is so easily operated as the incandescent lamp.

The Arc Lamp

The Carbon Arc which was very generally used for photographic purposes until the advent of panchromatic film stock, and talking pictures, lost considerable ground immediately after these two changes came into general practice. During the past ten years much has been written and said about the advantages of the Carbon Arc as a source of photographic lighting. However, it was not until considerable study had been given towards new design of auxiliary equipment that the Carbon Arc was regarded with much favour for general photographic requirements.

It has, of course, always been recognised that by reason of the crater of an Arc being almost a point source of light it had a distinct advantage over incandescent lamps in cases where beams of light with a very sharp "cut-off" were necessary. When it became apparent in colour photography that a light source was needed which much more nearly matched noon sunlight the impetus for greater research in the field of arc equipment brought forth new equipment which is now being used very generally in black and white photography. In the manufacture of this equipment it was deemed necessary to design so that carbons can operate at the manufacturers' rated amperage.

The Vapour Discharge Lamps

A third light source is being watched very carefully. I refer to the gaseous vapour discharge lamp. However, this source possesses both light and performance characteristics which render it unsuitable for motion picture studio lighting. Research is being carried on, and it is quite possible that this source may come into use if modifications can be made in its operating characteristics.

Early Lighting Equipment

Early lighting equipment consisted of a light source with a reflector at the back of it, which for the most part gave a flood of light on to the set. The best evidence of this type of lamp is still to be seen in the so-called twin broad-lamp, which in the incandescent field was an outgrowth of the twin side arc. Practice soon indicated the need of a light source which could be used as a modelling light, and the parabolic mirror spotlight and the plano-convex spotlight came into general use.

The Disadvantages of the Parabolic Mirror

Although the parabolic mirror spotlight is an extremely efficient unit when used as a spotlight, that is with a narrow beam divergence, it has the fault of throwing a beam pattern of "hot" outside rings and dark centres as the beam is widened. Incandescent equipment has the further disadvantage of practically no control of the front light of the filament, which finally brought into use sets of louvres placed in front of the lamp, often called "spill-rings."

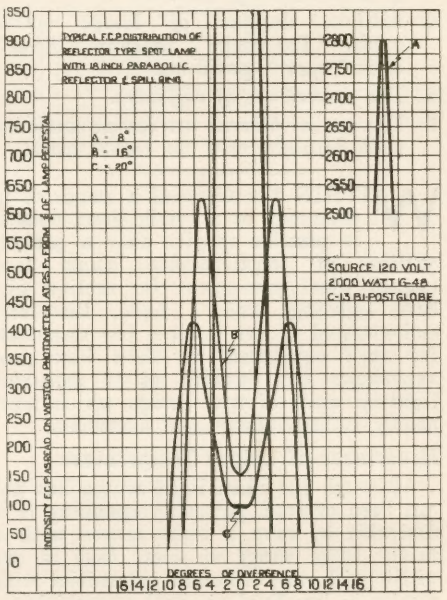

Figure 1

Since it was then found difficult to keep these louvres exactly in position the total efficiency of the unit dropped con-

siderably with the installation of spill-rings, since a considerable portion of the mirror was blocked out. However, their use was found necessary since the uncontrolled front light made it extremely difficult to secure proper lighting effects.

A spot lamp of this design has a rather objectionable characteristic in that light reflected from a considerable portion of the mirror is blocked off by the lamp house as the beam is widened, which means that a smaller angle of light is picked up by the mirror, and, therefore, less total light emitted from the equipment in the flood position than in the spot position.

Fig. 1 shows the characteristics of light emitted from the glass parabolic mirror.

Faceted Mirrors

Unless large reflecting surfaces are used, the intensity in the flood position is so low as to be ineffective. The dark centre of this type of lamp was so objectionable in lighting the motion picture set that several types of faceted mirrors, first in glass and then in metal, were used. This aplanatic mirror which, although it greatly decreased the efficiency of this unit in the spot position, helped to correct the dark centre, therefore came into fairly general use.

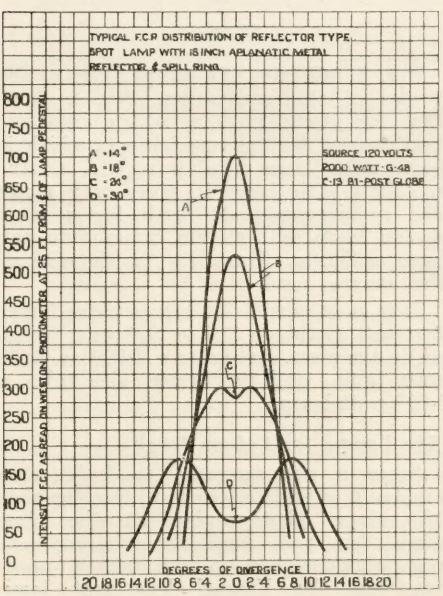

Figure 2

Fig. 2 shows the characteristics of light emitted from the aplanatic mirror.

The Use of Condensing Lenses

The plano-convex condensing lens in spot position overcame the difficulties of dark centres, hot rings, and uncontrolled front light. However, the efficiency of such a unit was exceedingly low, and, therefore, it was impractical to use this type of equipment except for special effect lighting. Although in equipment using the plano-convex lens a mirror was usually inserted behind the light source to pick up the back light and re-direct it through the lens, with the type of lamps then available, it was found so difficult to keep these mirrors properly focussed that they were generally discarded in actual practice. Fig. 3 shows the efficiency of a plano-convex unit.

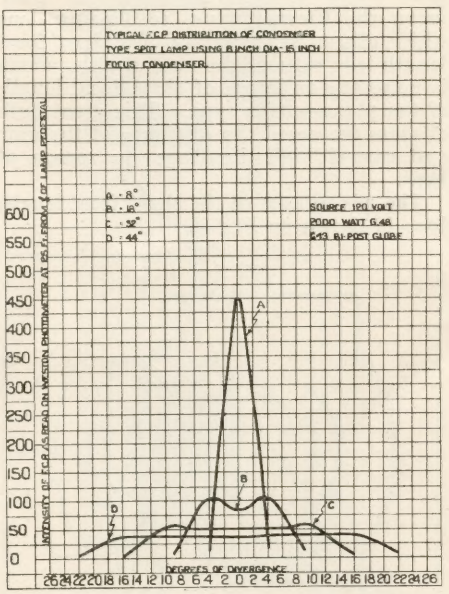

Figure 3

Characteristics Needed for Lighting Equipment

In discussing the needs of the Cameramen it soon became evident that lighting equipment which would more nearly meet their requirements should have the following basic characteristics:—

The light beam should be completely controlled, that is there should be no uncontrolled front light emitted from the

unit. It should be possible to get a sharp spot or a wide flood out of one unit and keep a beam pattern which would always be slightly high in intensity in the centre and taper off at the edges. The equipment should be small in size, light in weight, yet durable enough to withstand handling and frequent moving about.

For incandescent equipment it became apparent that lamps which were absolutely pre-focussed were an essential feature of the design, these lamps to be mounted in holders so that lamps could be changed without disturbing the focus of the unit. In short, it would be desirable to have the efficiency of the parabolic mirror spotlight combined with the beam pattern of the plano-convex condenser spotlight.

The Fresnel Lens

Towards this end several years of diligent study brought forth a spot lamp using the Fresnel type condensing lens which offers the advantage of a short focal length lens without the bulk of glass which is necessary on lenses of short focal length of the plano-convex type. This great bulk of glass decreased the efficiency of the unit and caused high breakage by reason of heat.

The advantages of the short focal length lens is shown in Fig. 4.

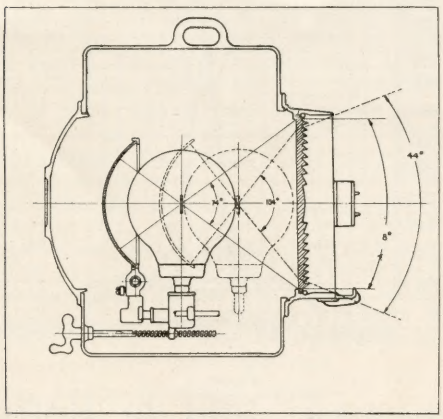

Figure 4

Pre-focussed Lamps

The need of the pre-focussed incandescent lamp had by this time become very apparent, and the lamp manufacturers produced what is commonly called the bi-post lamp, which has many advantages over the older types.

It was now possible to design a lamp holder and spherical mirror which would always keep the proper position of the filament with relation to the optical system. This lamp has the further advantage of being more compact, which enabled new equipment to be designed in smaller size for a given wattage. The spherical mirror, which picks up the back light of the filament and redirects it through the lens, is so mounted that lamps can be changed from the back, and this mirror pushed back into place without altering the focal position.

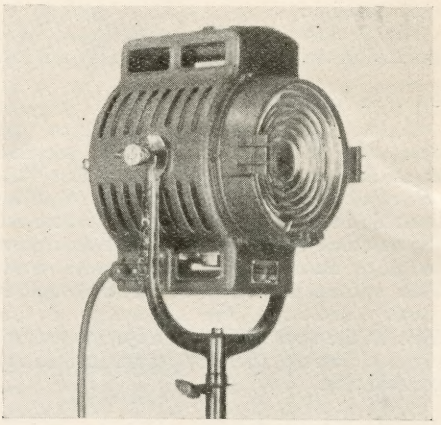

Figure 5

Fig. 5 indicates the compactness of the design of this equipment, Fig. 6 showing the beam pattern which indicates that, except for the very hot spot which is procurable from the parabolic mirror spotlight, this lamp in every way meets the requirements set forth for a more usable lamp so that the cameraman can have sufficient flexibility in the size of the sources used.

It is now possible to secure these lamps designed to take a 250 or 500 watt lamp, while the next size takes a 1,000 or 2,000 watt lamp, and the largest size takes a 5,000 watt lamp.

Arc Lamps for Colour Work

Since it was necessary to design new arc lamp equipment to meet the demands of colour photography at the time when this new incandescent equipment was being designed, it soon became apparent that the Fresnel lens spot lamp offered many advantages for arc lighting

as well as for incandescent lighting. Therefore two arc spot lamps were designed where the light crater of the arc was taken directly into the Fresnel lens

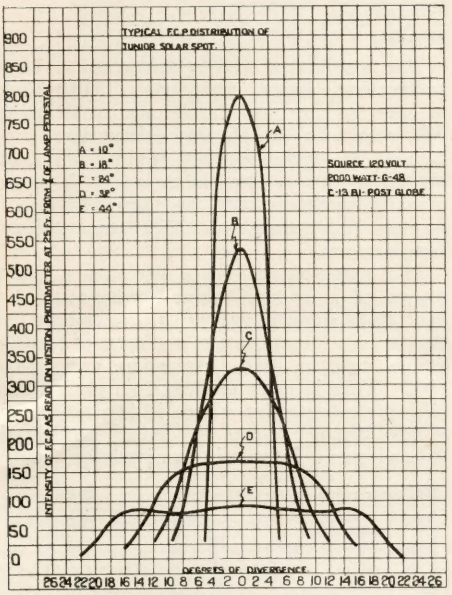

Figure 6

with a great improvement in the beam pattern over the 24-36in. Sun Arcs formerly used.

Fig. 7 shows the new equipment. Fig. 8 shows the beam pattern of a 36in. Sun Arc with the always objectionable dark centre caused by the shadow of the arc mechanism, and Fig. 9 shows the beam pattern using the Fresnel lens.

Importance of Constant Arc Current and Crater

In addition to this very advantageous beam pattern here again it was possible to design equipment which was much smaller in size than the old type of arc lighting equipment and which had many new uses which were formerly impossible. This arc equipment had to be used nearer the microphone in colour photography, therefore a new degree of quietness had to be built into its mechanism. Since fluctuations in the quality of light were not permissible, it was necessary to ensure constant colour quality by designing a fixed resistance so that the amperage at the arc would always be kept constant, and an automatic feed so that a stable crater could be held. Here again a light weight yet rugged equipment has been evolved with several new features which make for greater ease of handling on the set. All the control mechanism is mounted on the back plate of the lamp, so that for switching, striking and locking of this equipment the operator does not have to reach around the side of the lamp, and for trimming two large doors are mounted on the side of the lamp to facilitate the trimming.

The Correct Use of Diffusers

It is often found necessary to use either diffusers or filters in photographic light-

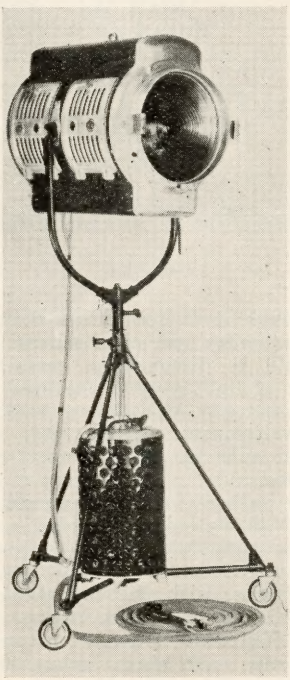

Figure 7

ing. The Fresnel lens spot lamp is extremely well designed in this respect since diffusers are much smaller in diameter, and, therefore, more easily handled and more easily maintained. Sturdy diffuser clips are permanently mounted on the lamps. The subject of diffusion is one that warrants considerable thought in most studios. A rather diligent study of

the practice in one large studio indicated that many times diffusers were used to cut intensity rather than to alter the quality of the light.

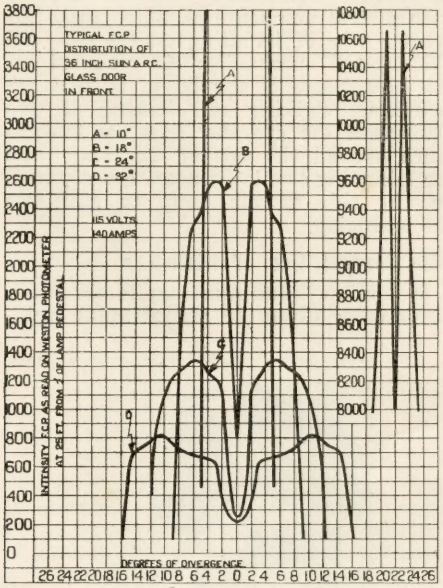

Figure 8

Although it is recognised that this is often necessary, yet as a general practice it should be discouraged, certainly if a number of light sources are used, because of the necessity of different requirements from each source. If the total intensity is found to be too high, it would be much more desirable to use sources of a lower wattage rather than to dissipate the excess of light by using diffusers.

In the particular studio in question it was found desirable to mark the Junior Solar Spots with distinguishing marks and instal in a certain number of these spots 1,000 watt lamps. A number of these lamps were always mounted on the spot rail and on the floor when the set was rigged. A great saving in wattage was made by changing to 1,000 watt lamps if the 2,000 watt intensity was too high.

Inside Frosted Lamps

Another efficient means of securing diffusion is the more generally used inside frosted lamps. There is not the loss of efficiency with the inside frosted lamp as with the cello glass or silk diffusers.

It is, of course, realised that there will always be special requirements which cannot be covered in a general discussion. However, close observation indicates that not enough attention has been given to the great loss of energy caused by careless use of diffusers.

Filters

The subject of filters opens up a very interesting, almost untouched, field which is open to the more studious cameraman who wants to weigh the colour temperature of his light sources against the film emulsion which he is using. I have already pointed out the desirability of having light sources of the same colour temperature.

If a cameraman starts out with a light source of a known colour temperature he can then experiment with variations in this colour temperature to secure results which will be both interesting and effective. This is most evident in lighting for colour photography where it is possible to secure warmer tones by using unfiltered incandescent lamps in conjunction with

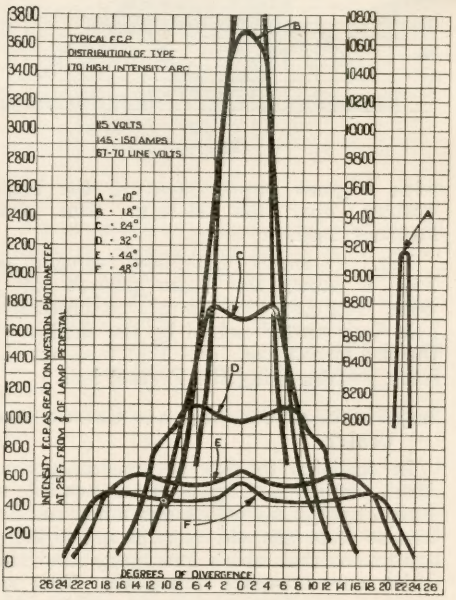

Figure 9

arc lamps. A splendid example of this will be seen in the picture "Dancing Pirate," which will be released shortly.

The use of filters is one of the easy ways to change the colour temperature of

a source. With incandescent lamps, variation of voltage at the source is a very effective way.

Unfortunately, at the present time changing of colour temperature is something which happens without the cameraman's knowledge, and many times to his decided disadvantage.

Importance of Voltage Control

It is necessary to point out that in addition to using lamps of proper design, the studio electrical department must also appreciate the importance of voltage control so that the cameraman is not let into the pitfall of very different intensities at different times of day, or on different days shooting the same set. For some time past I have advocated a rather simple check which the cameraman can make which, while it in no way interferes with his artistry in lighting the set, gives him a check on those variables which too often work to his disadvantage. This is the use of a small light meter, which, with a little practice, can be a quick and effective check against the pitfall of this variable. This is a subject which does not necessarily fit into a paper of this scope, but I felt it desirable to at least mention it here.

DISCUSSION

MR. JOHNSON: Mr. Linderman mentioned the difficulties experienced with keeping sufficiently constant voltage control on arc lamps, and it would be interesting to know whether similar difficulties are found to a greater extent with the incandescent type.

THE AUTHOR: The situation is more critical with incandescents than with arcs. Of course, in black and white photography it does not matter so much. It seems that you can shoot all the way from 100 ft. candles to 1,000 ft. candles and a lab. will eliminate your mistakes, but colour photography is very critical—even a variation of 5 volts gives trouble with incandescents, but we can actually stand for 7 or 8 volts before getting serious trouble with arc lamps.

MR. GEARY: Mr. Linderman has mentioned to us the difficulties and characteristics of arc and incandescent lamps, and it would be interesting to know what success attends the use of a mixture of them.

THE AUTHOR: You have to be very careful with mixing. You must put a blue filter in front of incandescents to take out the excess of red. When we wanted afternoon sunlight effects on a Spanish Plaza set we used arcs, without filters, but for moonlight effects we did filter the arcs with a blue filter, the evening interiors being lighted with the incandescents without filters.

MR. C. VINTEN: Would Mr. Linderman tell us whether he has experimented with a high-pressure mercury type of lamp?

THE AUTHOR: Yes. I find it has a few basic characteristics which make it impossible for use. One is spectral emission. Mercury vapour is very rich in blue-green and has almost no red, even at high pressures, which makes it difficult to use at the present time with existing filmstock. The operating characteristic is bad; it is a lamp that is actually on or off and, being used on A.C., you would have a lot of frames actually not exposed at all. These bad characteristics must be altered before we can see much use for it in cinematography.

MR. WHITEHOUSE: Mr. Linderman, have you made any experiments on the effect on the life of an ordinary incandescent from the increased heat due to this restricted housing?

THE AUTHOR: The lamps are very well ventilated. The most we do is to put them up a few degrees, and the lamps are already operating at a high temperature. A trouble that we did find was bulb distortion or blistering, which took place when the gas pressure on the inside of the bulb was greater than it should be. We actually have a splendid draught in our lamps which cools them quite well. Blackening inside the bulb causes distortion. The heat concentrates where the blackening is deposited, finally causing a large blister. The filament is not affected; it is only the glass you have to worry about.

MR. MORGAN: I would like to ask Mr. Linderman what sort of filament structure is used now in the U.S.A.—whether it is bunch filament or bi-plane.

THE AUTHOR: We take a bi-plane and reconstruct it to get what is not exactly a point source but a square source. You will find that in the studios they will burn a lamp the way they like instead of the way they should—(laughter)—with the result that the upper filament gets heated by the coils of the lower one and they burn out. The general source we now make is a monoplane filament used with a spherical mirror.

MR. JOHN NEW: Can I ask whether in colour photography the broadside and overhead fittings are equipped with general service lamps of 1,000-hour rating, such as are used in house lighting?

THE AUTHOR: Any incandescent lamps used for colour photography, either in conjunction with arc lamps, or alone, must all be designed for the same lumen per watt efficiency. General service lamps of 1,000-hour rating will be useless. Where it has been necessary to use equipment which was designed for the general service lamps we have used a 2,000-watt photo flood in the PS 52 bulb which has a life rating of approximately 18 hours.

MR. GEARY: The author has said he was referring to one colour process, but is it not in the main the same for all colour systems?

THE AUTHOR: Very likely, yes.

MR. PEREIRA: One thing which puzzles me in the sphere of lighting for colour photography is the sudden change sometimes observed in the complexion of a charming lady, which transforms her for a few moments into the likeness of a Red Indian.

THE AUTHOR: With regard to the question of faults in colour films raised by MR. PEREIRA, they must be due to a combination of bad equipment and lack of knowledge, for which we must take the blame, and trust we may before long be able to correct these faults.

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